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METHOD AND APPARATUS FOR CARRYING TELEPHONY NETWORK
TRAFFIC OVER AN ATM NETWORK

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Method and Apparatus For Carrying Telephony Network Traffic Over An ATM Network

FIELD OF THE INVENTION

5 The field of invention relates to networking, generally; and more specifically, to carrying telephony traffic over an ATM network.

BACKGROUND

Figure 1 shows an example of a traditional approach for carrying
10 telephony traffic. Telephony traffic is traditionally carried over a telephony network 103. As is known in the art, a telephony network 103 employs: 1) circuit switching to set up a connection; and 2) time division multiplexing (TDM) to transport information over the connection. Some examples of a telephony network include a Public Switched Telephone Network (PSTN) or an Integrated
15 Services Data Network (ISDN).

Telephony traffic is traffic traditionally carried by a telephony network such as voice traffic and facsimile (FAX) traffic. In the example of Figure 1, telephony traffic is carried by the telephony network 103 from a source device 101 (e.g., a telephone mouthpiece or transmitting FAX modulator) to a
20 destination device 102 (e.g., a telephone earpiece or receiving FAX demodulator).

Note that, as an example, both the source device 101 and the destination device 102 are coupled to a corresponding local exchange or end office 180, 181 (LE/EO). A local exchange typically handles traffic from a smaller geographic

region while a central exchange typically handles traffic from a larger geographic region. Because either may apply to the exemplary depiction of Figure 1, the notation LE/EO 180, 181 has been used.

The source device 101 is coupled to LE/EO 180 (which may also be referred to as the source LE/EO 180) and the destination device 102 is coupled to LE/EO 181 (which may also be referred to as the destination LE/EO 181). An LE/EO, such as source LE/EO 180, provides for the efficient collection of information from different source devices. That is, traffic entering the telephony network 103 (e.g., from a plurality of different telephone mouthpieces and/or transmitting FAX modulators) may be combined at a LE/EO 180 and transported further upstream (i.e., deeper into the telephony network 103) over a single trunk line 113 (e.g., a T1 line).

Similarly, a LE/EO such as destination LE/EO 181 also provides efficient distribution of information to different destination devices. That is, traffic leaving the telephony network 103 (e.g., toward a plurality of different telephone earpieces and/or receiving FAX demodulators) may be collectively received at a LE/EO from a single trunk line 118 (that is coupled to deeper regions of the telephony network 103) and then distributed from the LE/EO to the appropriate destination devices.

For any connection carried by the telephony network 103, the connection's establishment (e.g., call setup and teardown procedures) and routing path are controlled by a telephony signaling control network 104. An example of a

telephony signaling control network 104 is a Signaling System 7 (SS7) network. SS7 networks, which include local and national variants, are implemented world-wide.

As an example, when an individual at the source device 101 attempts to
5 call an individual at the destination device 102, the information indicative of the source and destination devices (e.g., an Initial Address Message (IAM) message) is typically forwarded from the source LE/EO 180 to a signaling transfer point (STP) 105 within the telephony signaling control network 104. The STP 105 (which may also be referred to as the "source" STP 105) helps arrange
10 notification of the call to STP 106 (which may also be referred to as the "destination" STP 106) responsible for the destination LE/OE 181.

Upon such notification, the destination STP 106 will forward the IAM message to the destination LE/EO 181. The destination LE/OE will then notify the destination device 102 of the call (e.g., via a "RING" signal). The destination
15 LE/EO 181 is also informed, from the telephony signaling control network 104, which TDM time slot on trunk line 118 that the information from the call is to be sent along. Generally, when multiple switches (i.e., more than two) are used to carry a call, a switch communicates the TDM time slot and trunk line (through the telephony signaling control network 104) to the next switch used to carry the
20 call.

A problem with telephony networks is their inherent emphasis on the transportation of telephony traffic. With the growth of the Internet, service

1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729 2730 2731 2732 2733 2734 2735 2736 2737 2738 2739 2740 2741 2742 2743 2744 2745 2746 2747 2748 2749 2750 2751 2752 2753 2754 2755 2756 2757 2758 2759 2760 2761 2762 2763 2764 2765 2766 2767 2768 2769 2770 2771 2772 2773 2774 2775 2776 2777 2778 2779 2780 2781 2782 2783 2784 2785 2786 2787 2788 2789 2790 2791 2792 2793 2794 2795 2796 2797 2798 2799 2800 2801 2802 2803 2804 2805 2806 2807 2808 2809 2810 2811 2

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BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example, and not limitation, in the Figures of the accompanying drawings in which:

Figure 1 shows a traditional telephony network and telephony signaling control network;

Figure 2 shows a call agent based telephony signaling control network that uses traditional SS7 signaling and an ATM network; and

Figure 3 shows a method for establishing a connection that transports traffic from a telephony network over an ATM network.

DETAILED DESCRIPTION

A method is described that sends ATM source identification and an ATM-TDM correlation tag from an ATM source gateway to a telephony signaling control network. At an ATM destination gateway, the ATM source identification and the ATM-TDM correlation tag are received after being sent from the telephony signaling control network. The ATM-TDM correlation tag is then sent from the ATM destination gateway to the ATM source gateway to establish a connection between the ATM destination gateway and the ATM source gateway.

Figure 2 shows a solution to the problem described in the background. In the approach of Figure 2, an ATM network 207 is used as a "backbone" to carry (e.g., over long distances) telephony traffic between two telephony networks 203a, 203b. Because ATM employs cell switching technology, ATM efficiently transports both voice traffic and data traffic. As such, a service provider may be inclined to deploy ATM technology.

However, uses of a traditional telephony network may still be desirable. For example, to extend the original investment made in their own TDM equipment, customers of a service provider may decide to communicate to the service provider through a traditional telephony network 203a, 203b. In other cases, traditional telephony networks may be suitable because the transportation of data traffic to a particular region or customer is insignificant. Note that, in any of these cases, traditional telephony networks 203a, 203b may correspond to

networks operated by the service provider or a customer of the service provider or a combination of both.

In an embodiment, the ATM network 207 may approximately correspond to a wide area network (WAN) that carries traffic over longer distances while
5 telephony networks 203a,b may approximately correspond to local networks that carry traffic over shorter distances (e.g., such as local exchange (LE) network or customer premise network). The network architecture 200 of Figure 2 indicates that traffic between a first and second telephony network 203a, 203b is carried by an ATM network 207.

10 That is, for example, if a call is made from a source device 201 to a destination device 202 (where the source device 201 is communicatively coupled to a first telephony network 203a and the destination device 202 is communicatively coupled to a second telephony network 203b), the call is routed from the first telephony network 203a through the ATM network 207 and then
15 from the ATM network 207 to the second telephony network 203b. In this manner, the transportation of the call is transparently carried as ATM traffic even though the source and destination devices 201, 202 employ traditional telephony network transportation techniques.

In a basic case, telephony network 203a may correspond to a source
20 LE/EO (such as source LE/EO 180 of Figure 1) and telephony network 203b may correspond to a destination LE/EO (such as destination LE/EO 181 of Figure 1). In this case, trunk lines 213, 218 may respectively correspond to trunk lines 113,

118 (e.g., T1 lines) in the sense that they carry the call from the source and destination LE/EOs 180, 181 to deeper regions of the network. It is important to note, however, that telephony networks 203a, 203b may be comprised of any equipment used to implement a telephony network. As such, trunk lines 113, 5 118 are not necessarily tied to an LE or OE.

The approach associated with Figure 2 integrates the connection establishment capabilities of both the ATM network 207 and the telephony signaling control network 204 so that an end-to-end connection from the source device 201 to the destination device 202 may be realized. In order to realize such 10 a connection, as described in more detail below, information is exchanged between the ATM network 207 and the telephony signaling control network 204.

Recall from the discussion in the background concerning Figure 1 that if a source device 101 attempts to call a destination device 102, information indicative of the source and destination devices is typically forwarded to source 15 STP 105. Referring to Figure 2, a similar procedure may be applied.

That is, communication interface 214 may correspond to communication interface 114. As such, when the source device 201 initiates a call to the destination device 202, information indicative of the source and destination devices (e.g., an IAM message, an ISDN setup message, an MGCP notification 20 message) is forwarded over communication interface 214 from the first telephony network 203a to a telephony signaling control network 204.

Note that the communication interface 214 may be one of many different means used for communicating telephony signaling information between a telephony network 203a and a telephony signaling control network 204. Such means may include (but are not limited to including): SS7 Integrated Services
5 digital network User Part (ISUP) signaling, the Media Gateway Control Protocol (MGCP), the ITU h.248 protocol, MEGACO, and an SCTP or RUDP based backhaul of ISDN signaling, etc.

After the telephony signaling control network 204 receives information that is indicative of the source 201 and destination 202 devices for the particular
10 call, the telephony signaling control network 204 helps establish the call path through the telephony network 203a that is coupled to the source device 201 by reserving appropriate resources and providing appropriate signaling. The telephony signaling control network 204 also decides that the call will be directed over a particular trunk line 213 that couples the telephony network 203a to the
15 ATM network 207.

This decision may be based on trunk availability between telephony network 203 and ATM network 207 by routing algorithms that are executed in the telephony signaling control network. Each trunk line 213, 218 may also be implemented as a "trunk group" or a "multiplexed line" and, as such, may also
20 be referred to as a "trunk group/multiplexed line".

When the telephony signaling control network 204 receives the source and destination information from the telephony network 203a, notification of the call

(i.e., call notice) is sent from the telephony signaling control network 204 to a source gateway 208 within the ATM network 207. The call notification may include a description of the particular TDM time slot on trunk line 213 that will be used for the call. In cases where more than one trunk line 213 could apply, the
5 call notice may also describe which particular trunk line will be used for the call.

An ATM source gateway 208 provides access to the ATM network 207 (via trunk line 213) for the telephony network 203a that is coupled to the source device 201. The interface 215 between the telephony signaling control network 204 and the ATM source gateway 208 may take various forms such as a gateway
10 control protocol, a signaling backhaul protocol or a combination of the two. Examples of a gateway control protocol include (but are not necessarily limited to) MGCP, MEGACO and the ITU h.248 protocol. Examples of a signaling backhaul protocol include (but are not necessarily limited to) Stream Control Transmission Protocol (SCTP) and Reliable User Datagram Protocol (RUDP).

15 After the ATM source gateway 208 receives the call notice, it responds to the telephony signaling control network (e.g., in the form of an acknowledgement) with: 1) an ATM source id (e.g., information that reflects the position of the ATM source gateway 208 within the ATM network 207 such as the ATM address of the ATM source gateway 208); and 2) an ATM-TDM
20 correlation tag (i.e., information that associates the ATM connection that will be used to transport the call with TDM parameters (e.g., trunk line and TDM time

slot) that will be used to transport the call). Note that the ATM-TDM correlation tag may be a randomly generated number.

After the ATM source id and ATM-TDM correlation tag are received by the telephony signaling control network 207 (e.g., by call agent 205), both are sent from the telephony signaling control network 204 to an ATM destination gateway 209. The telephony signaling control network 204 also helps establish the remainder of the call path by reserving appropriate resources and providing appropriate signaling within telephony network 203b that is coupled to the destination device 202. Thus, information that is indicative as to which particular TDM time slot on trunk line 218 that is being reserved for the call is also sent along with the ATM source id and the ATM-TDM correlation tag from the telephony signaling control network 204 to the ATM destination gateway 209. An ATM destination gateway provides access to ATM network 207 for telephony network 203b.

A call agent, such as call agent 205 and call agent 206, are devices capable of communicating with multiple protocols that may be used to communicate with a telephony signaling control network 204. For example, typically, a call agent not only communicates according to traditional SS7 based signaling but also other communication protocols that may be used to interface with a telephony signaling control network (e.g., MGCP, ITUh.248, MEGACO etc.). Thus, for example, if interface 215 corresponds to an MGCP interface and if

interface 214 corresponds to an SS7 based interface, a call agent may be used to understand the signaling associated with both interfaces.

An ATM destination gateway 209 provides access to the ATM network 207 (via trunk line 218) for the telephony network 203b that is coupled to the destination device 202. In an embodiment, as seen in Figure 2, the ATM source id and ATM-TDM correlation tag are forwarded from a source call agent 205 to a destination call agent 206 within the telephony signaling control network 204. In a further embodiment, the ATM source id and ATM-TDM correlation tag are sent through the telephony signaling control network 204 within an IAM message.

The destination call agent 206 then forwards the ATM-TDM correlation tag and ATM source id to an ATM destination gateway 209 over communication interface 216. The destination call agent 206 also helps establish, over communication interface 217, the call in the telephony network 203b that is coupled to the destination device 202. As such, the destination call agent 206 also informs the ATM destination gateway 209 as to which TDM time slot on trunk line 218 is being reserved for the call. If more than one trunk line exists the telephony signaling control network 204 may also inform the ATM destination gateway 209 as to the proper trunk line to be used for the call.

Again, communication interface 216 may take various forms such as a gateway control protocol, a signaling backhaul protocol or a combination of the two. Examples of a gateway control protocol include (but are not necessarily

limited to) MGCP, MEGACO and the ITU h.248 protocol. Examples of a signaling backhaul protocol include (but are not necessarily limited to) Stream Control Transmission Protocol (SCTP) and Reliable User Datagram Protocol (RUDP).

- 5 Also, communications interface 217 may be one of many different means used for communicating telephony signaling information between a telephony network 203b and a telephony signaling control network 204. Such means may include (but are not limited to including): SS7 Integrated Services digital network User Part (ISUP) signaling, the Media Gateway Control Protocol (MGCP),
- 10 MEGACO, the ITU h.248 protocol, an SCTP or RUDP based backhaul of ISDN signaling, etc.

Upon receipt of the ATM-TDM correlation tag and ATM source id, the ATM destination gateway 209 initiates a switched virtual circuit (SVC) connection establishment sequence in which the ATM-TDM correlation tag is

15 sent along with traditional switched virtual circuit (SVC) connection signaling from the ATM destination gateway 209 to the ATM source gateway 208.

- An SVC connection may be established by sending a SETUP message from a connection destination within an ATM network (e.g., ATM destination gateway 209) to a connection source within an ATM network (e.g., ATM source
- 20 gateway 208). The SETUP message typically propagates through the ATM network 207 by hopping at each node that will be used to carry the connection.

For example, referring to Figure 2, if the connection is to be carried over nodes 212, 211, and 210, (which may be determined as a result of the execution of a routing algorithm) the SETUP message traverses each of these nodes. As a result of the SETUP message being sent, VPI/VCI information associated with the connection is updated into the mapping tables of each node used to support the connection.

In an embodiment, each SETUP message includes the aforementioned ATM-TDM correlation tag that was sent to the ATM destination gateway 209 by the telephony signaling control network 204. SETUP messages without an ATM-TDM correlation tag are known in the art. A SETUP message is partitioned into various fields (which are referred to as Information Elements (IEs), similar to the manner in which a packet header is organized. In one embodiment, the ATM-TDM correlation tag is placed within the Called Party Sub-Address IE of a SETUP message (e.g., anywhere in the later 19 octets of this field). In another embodiment the ATM-TDM correlation tag is placed within the Generic Identifier Transport (GIT) IE. In another embodiment the ATM-TDM correlation tag is placed within the Generic Application Transport (GAT) IE. In another embodiment, the ATM-TDM correlation tag is placed within the User to User IE. In another embodiment, the ATM-TDM correlation tag is placed within the Network Call Correlation Identifier (NCCI) IE. In another embodiment, the ATM-TDM correlation tag is placed within the Calling Party Sub Address IE. In another embodiment, the ATM-TDM correlation tag is placed within the Served

User Generated Reference IE (SUGR). Alternate embodiments may place the ATM-TDM correlation tag in other regions of the SETUP message not listed above where such placement is consistent with applicable industry standards.

Eventually, a SETUP message will reach the ATM source gateway 208.

- 5 The SETUP message received by the ATM source gateway 208 will include the ATM-TDM correlation tag. Thus, in a sense, after the ATM-TDM correlation tag was created by the ATM source gateway 208 it was "looped" through the telephony signaling network 204 and the ATM network 207. Recall that the telephony signaling control network 204 (as part of the call notice previously
- 10 provided through communication interface 215) has already notified the ATM source gateway 208 as to which TDM time slot on trunk line 213 that the call will be carried over.

- The ATM-TDM correlation tag is used by the ATM source gateway 208 to correlate the SETUP message with the particular TDM time slot on trunk line 213
- 15 that the call will be carried over. That is, recalling that the ATM source gateway 208 originally generated the ATM-TDM correlation tag in light of notification of the call, upon receipt of the ATM-TDM correlation tag within the SETUP message the ATM source gateway 208 can update its mapping tables (or similar information) so that the payload of cells sent from/to node 212 (having the
- 20 appropriate VPI/VCI information for the connection) are transported to/from the trunk 213 and TDM time slot that was specified by the telephony signaling control network 204.

Associated with this update, consistent with ATM SVC call establishment sequencing, ATM source gateway 208 sends a CONNECT message to the ATM destination gateway 209 through the nodes used to transport the call (e.g., nodes 212, 211, 210 as seen in Figure 2). After the CONNECT message has been
5 received by the ATM destination gateway 209, an end to end connection between the source device 201 and the destination device 202 has been established.

Figure 3 shows a methodology that reviews, at a high level, the “looping” of the ATM-TDM correlation tag described above. Consistent with the description above, an ATM connection and ATM source id are sent 301 from an
10 ATM source gateway to a telephony signaling control network. Then, the ATM-TDM correlation tag and ATM source id are sent 302 from the telephony signaling control network to an ATM destination gateway. Then, the ATM-TDM correlation tag is sent 303 within the ATM network, via a SETUP message, from the ATM destination gateway to the ATM source gateway.

15 It is important to point out that the techniques described above may be employed by any ATM network. Thus, these techniques may be employed not only by a purely cell switched ATM network but also by an ATM Adaptation Layer Type 2 (AAL2) packet network. In this case, an Establish Request (ERQ) message is used instead of a SETUP message and an Establish Confirm (ECF)
20 message is used instead of a CONNECT message. Furthermore, rather than using VCI information, VCI/CID information is employed. ATM networks that comprise a combination of AAL2 packet and purely cell switched architectures

may also use these techniques if appropriate translation of the SETUP/ERQ and CONNECT/ERF messages are provided as well as any needed bearer network conversions (e.g., from multiplexed to non-multiplexed cells).

It is also important to point out that the methodologies may be

- 5 implemented at least partially with software. Thus it is to be understood that embodiments of this invention may be used as or to support software programs executed upon some form of processing core (such as a the CPU of a computer or an embedded microprocessor) or otherwise implemented or realized upon or within a machine readable medium. A machine readable medium includes any
- 10 mechanism for storing or transmitting information in a form readable by a machine (e.g., a computer). For example, a machine readable medium includes read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; electrical, optical, acoustical or other form of propagated signals (e.g., carrier waves, infrared signals, digital
- 15 signals, etc.); etc.